ALUMINUM CAP WITH ELECTROLESS NICKEL/IMMERSION GOLD

FIELD OF THE INVENTION

The present invention relates generally to fabrication of semiconductor devices, and more specifically to methods of fabricating wafer bumps.

BACKGROUND OF THE INVENTION

Electroless nickel/gold (Ni/Au) under bump metal (UBM) is a commonly used UBM for wafer bumping used in Flip Chip applications because it's a low cost maskless process. This process involves the dipping of silicon nitride (Si_3N_4)/polyimidecover/benzocyclobutene (BCB) passivated wafers into a series of plating baths to grow a thick layer of Ni studs (UBM). After this UBM process, the wafer is sent for bumping and reflow to form round solder ball interconnects.

However, the adhesion of this electroless Ni/Au UBM to the passivation layer is poor, and during plating, the plated Au will follow a capillary action and become deposited on the side wall of the PI/BCB passivation layer. During solder bump reflow, this will cause solder to flow into the side wall of the passivation layer as Au is proven to be a good wetting layer of solder. Thus, the solder will attack the underlying aluminum (Al) pad causing corrosion to the Al pad and affecting the reliability of the package.

U.S. Patent No. 6,452,270 B1 to Huang describes increased adhesion between the UBM and passivation by using a Ti UBM with a closed-loop shape.

U.S. Patent No. 6,521,996 B1 to Seshan describes a lower adhesion layer that provides good adhesion to the passivation layer.

U.S. Patent No. 6,426,281 B1 to Lin et al. describes a passivation layer that increases the adhesion to the UBM.

SUMMARY OF THE INVENTION

Accordingly, it is an object of the present invention to provide improved methods of forming wafer bumps.

Other objects will appear hereinafter.

It has now been discovered that the above and other objects of the present invention may be accomplished in the following manner. Specifically, a structure having a metal bond pad formed thereover is provided. A patterned cover layer is formed over the structure. The patterned cover layer including an opening exposing a portion of the metal bond pad. The patterned cover layer opening including side walls. A metal cap layer is formed over at least the exposed portion of the metal bond pad and the patterned cover layer side walls. A solder bump is formed over the metal cap layer. The invention further includes a solder bump structure formed from this method.

BRIEF DESCRIPTION OF THE DRAWINGS

The features and advantages of the present invention will be more clearly understood from the following description taken in conjunction with the accompanying drawings in which like reference numerals designate similar or corresponding elements, regions and portions and in which:

Figs. 1 to 6 schematically illustrate a preferred embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The method of the present invention forms, inter alia, an additional layer of metal over the metal bond pad to prevent exposure of the cover side walls as the additional layer of metal covers up the cover side walls.

Initial Structure - Fig. 1

Fig. 1 schematically illustrates a structure 10 having a metal bond pad 12 formed thereover.

Structure 10 is preferably a semiconductor wafer comprised of silicon or germanium and is more preferably a silicon semiconductor wafer as will be used for illustrative purposes hereafter.

Metal bond pad 12 is preferably from about 0.5 to 1.5 µm thick and is more preferably from about 1.0 to 1.5 µm thick; and is preferably comprised of aluminum (Al) or AlSi and is more preferably aluminum (Al) as will be used for illustrative purposes hereafter.

Formation of Patterned Cover Layer 14 - Fig. 2

As shown in Fig. 2, a patterned cover polyimide layer 14 having opening 15 is formed over the Al bond pad 12, exposing a portion 19 of the Al bond

pad 12. Cover layer 14 is preferably a polyimide/benzocyclobutene (BCB) stack as will be used hereafter for purposes of illustration.

Polyimide/benzocyclobutene (BCB) layer opening 15 includes exposed side walls 11. The polyimide/benzocyclobutene (BCB) layer 14 may be patterned to form the opening 15 by, for example, photolithography and etching. The patterned polyimide/benzocyclobutene (BCB) layer opening 15 has a width of preferably from about 30 to 90 μm and more preferably from about 30 to 60 μm.

Polyimide/benzocyclobutene (BCB)layer 14 has a combined thickness of preferably from about 5.0 to 10.0 μm and more preferably from about 5.0 to 6.0 μm.

Formation of Additional Metal Layer 16 - Fig. 3

As shown in Fig. 3, an additional metal layer 16 is formed over the Al bond pad 12, polyimide/benzocyclobutene (BCB) layer 14 and the side walls 11 of polyimide/benzocyclobutene (BCB) layer 14 to a thickness of preferably from about 0.5 to 1.0 μm and more preferably from about 0.8 to 1.0 μm. The additional metal layer 16 is preferably formed by sputtering.

Additional metal layer 16 is preferably comprised of aluminum (Al) or AlSi and is more preferably aluminum (Al) as will be used for illustrative purposes hereafter. Additional metal layer 16 is preferably comprised of the same metal as is the metal bond pad 12.

Patterning of Additional Al Layer 16 - Fig. 4

As shown in Fig. 4, the additional Al layer 16 is patterned to form a patterned additional Al layer/Al cap layer 16' that at least covers the Al bond pad 12 and the side walls 11 of polyimide/benzocyclobutene (BCB) layer 14.

Double Zincation Process Activated Surface 19 and Electroless Nickel 18/Immersion Gold 20 Layers Over Al Cap Layer 16' - Fig. 5

As shown in Fig. 5, the Al cap layer 16′ is subjected to a double zincation process to form:

a double zincation activated surface 19 on Al cap layer 16′;

an electroless nickel layer 18 over the double zincation activated surface 19 of Al cap layer 16′ to a thickness of preferably from about 4.8 to 5.2 μm and more preferably about 5.0 μm; and

an immersion gold (Au) layer over the electroless nickel layer 18 to a thickness of preferably from about 0.09 to 0.11 μm and more preferably about 0.10 μm.

Formation of Rounded Solder Bump 22 - Fig. 6

As shown in Fig. 6, a solder bump is formed over the immersion gold layer 20 and is then subjected to a reflow process to form rounded solder bump 22. Rounded solder bump 22 is preferably comprised of a tin lead alloy (SnPb), a tin silver copper alloy (SnAgCu), a tin silver alloy (SnAg) or a tin copper (SnCu) and is more preferably a tin silver copper alloy (SnAgCu).

It is noted that due to the formation of the Al cap layer 16' which is subjected to double zincation activated process to form: a double zincation active Al surface 19; an electroless nickel layer 18; and an immersion gold layer 20; there is no electroless nickel layer 18/immersion gold layer 20 - polyimide interface so that the Al bond pad 12 is not subject to corrosion. Further, good adhesion between the Al bond pad/Al cap layer 16' and the polyimide is achieved, leading to improved reliability of the package.

The rounded solder bump 22 will come in contact with polyimide layer 14/BCB only at the edge of the under bump metal (UBM).

Advantages of the Invention

The advantages of one or more embodiments of the present invention include:

1) increased thickness of Al bond pad which could otherwise lead to serious pitting during the double zincation process; and

2) increased standoff (overall height) of solder bump thus improving reliability performance.

While particular embodiments of the present invention have been illustrated and described, it is not intended to limit the invention, except as defined by the following claims.